MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1 2022 / 2023 (TERM ID 2210)

ECE3296 – DIGITAL IMAGE AND VIDEO PROCESSING

(CE)

13 FEBRUARY 2023
2.30 p.m. - 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 9 printed pages with **FOUR** questions only.
2. Answer **ALL** questions.
3. Write your answers in the Answer Booklet.

Question 1

(a) Briefly explain the following levels of image processing:

i. Low-level image processing
ii. Mid-level image processing
iii. High-level image processing

Match the different levels of image processing above to the digital image processing system shown in Figure Q1A.

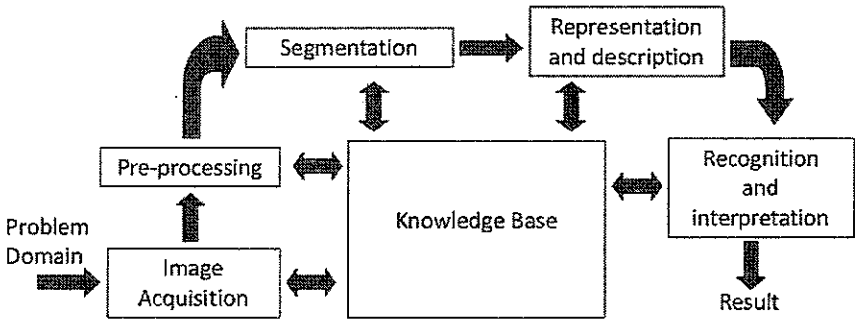


Figure Q1A

[9 marks]

(b) With the aid of a suitable diagram, describe how indexed images can be used to reduce the number of bits per pixel for color images without significantly compromising the image quality.

[4 marks]

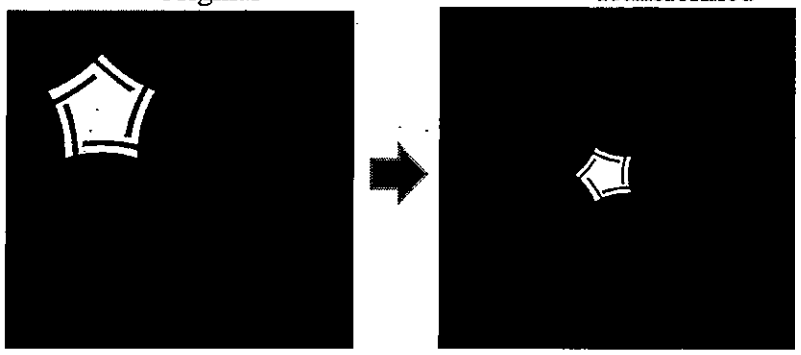
(c) Image subtraction is often used in industrial applications for detecting missing components in product assembly. Suggest a simple image-based system to detect missing components utilizing image subtraction.

[4 marks]

(d) Suggest all the geometrical operations involved in transforming the binary images in Figure Q1B. Deduce a possible transformation matrix T for each transformation. Justify your answer.

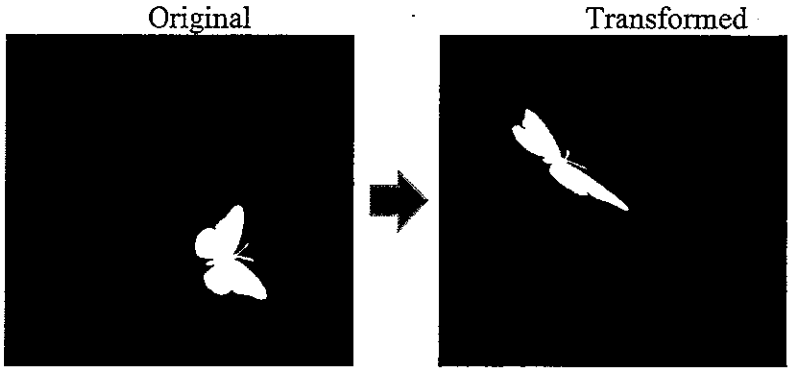
Continued...

(i)



[4 marks]

(ii)



[4 marks]

Figure Q1B

Continued...

Question 2

(a) Figure Q2A shows several intensity transformation techniques commonly used in image enhancement by point processing. Let $L = 256$, complete Table Q2A in your answer script to illustrate the mapping of several input and output gray levels for the identity, negative and log transformations.

Table Q2A

Input Grey Level	Output Grey Level		
	Identity	Negative	Log
0			
$L/4 + 5$			
$3L/4 - 5$			
L-1			

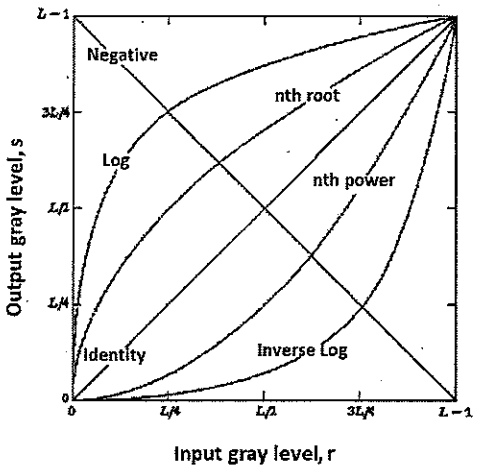


Figure Q2A

Briefly explain the effect of the three intensity transformations.

[8 marks]

(b) Figure Q2B shows a 3×3 image with the horizontal (H) and vertical (V) Prewitt operators.

(i) By using symmetric padding, apply the Prewitt operators to the image.

[6 marks]

(ii) Determine the resulting gradient image using the gradient approximation function $\nabla f \approx |G_x| + |G_y|$

[3 marks]

Continued...

48	48	47
200	201	202
199	200	199

Image

-1	0	1
-1	0	1
-1	0	1

Prewitt Operator (H)

-1	-1	-1
0	0	0
1	1	1

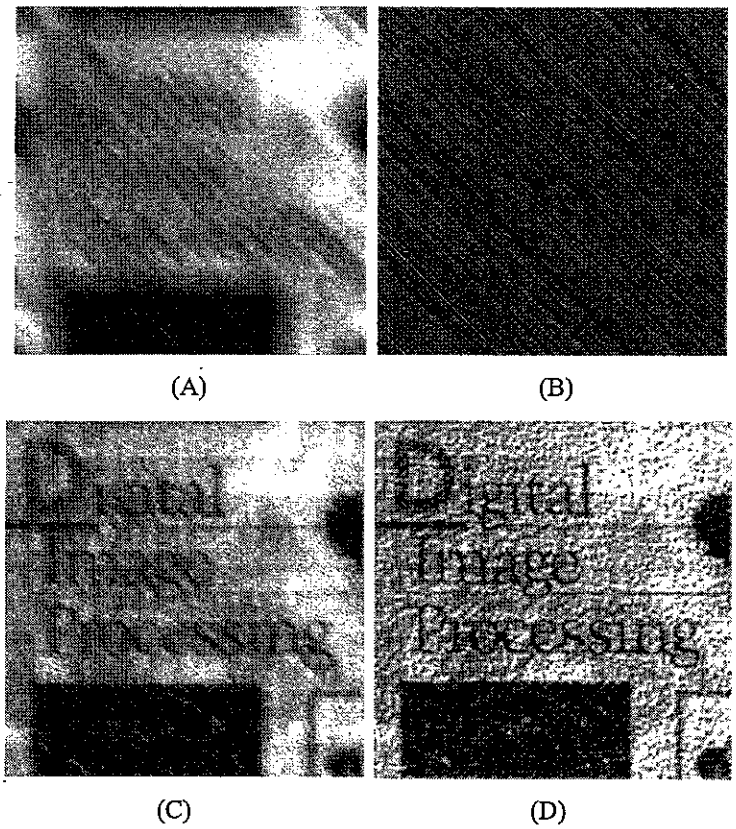
Prewitt Operator (V)

Figure Q2B

(iii) Suggest a suitable threshold to detect the edges in the image.

[2 marks]

(c) Figure Q2C shows a heavily degraded image (A), together with its restored images using three different image restoration filters (B, C, D). Suggest the restoration filters used to produce the images in B, C and D. Justify your answer.



(A) (B)

(C) (D)

Figure Q2C

[6 marks]

Continued...

Question 3

(a) Figure Q3A shows a 7×7 image for segmentation. Using the shaded and underlined pixel as the seed pixel, apply the region growing technique on the image based on 8-connectivity and using 3 as the threshold for grow (i.e. grow if the difference between pixel values is less or equal to 3).

10	10	10	62	10	10	10
10	10	10	69	70	10	40
59	10	60	64	59	56	60
10	59	10	**60**	70	10	62
10	60	59	65	67	48	65
10	10	10	10	54	10	40
10	10	10	10	10	10	10

Figure Q3A

[5 marks]

(b) As a computer programmer, you are required to design a program that can train the computer to count the number of positive (dark) and negative (light) cells as shown in Figure Q3B.

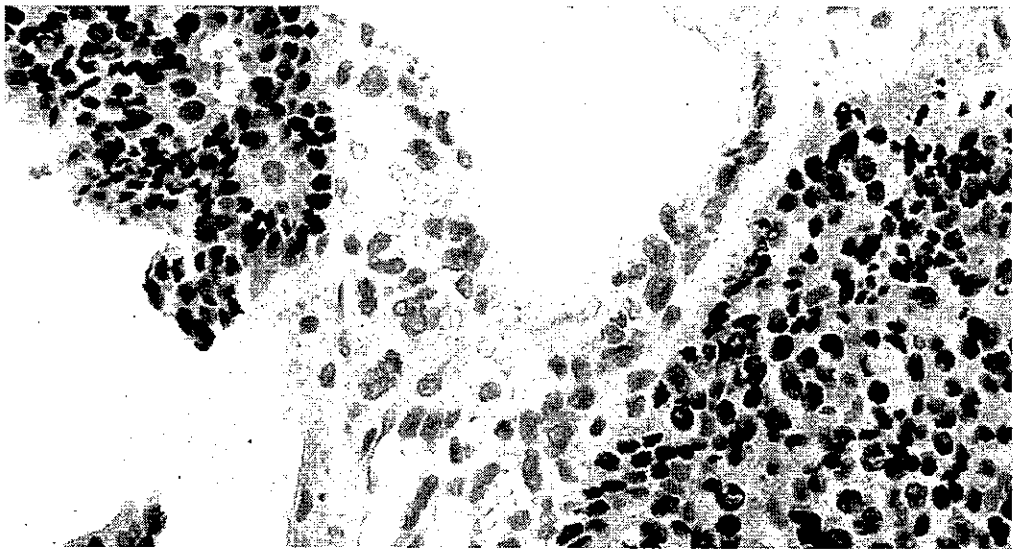


Figure Q3B

Continued...

Design your program by formulating a hypothesis for each stage of image processing system below:

- Pre-processing
- Segmentation
- Representation and description
- Recognition and interpretation

[12 marks]

(c) Figure Q3C shows the confusion matrix for a 9-class classification problem. The right-most column indicates the "Reject' class. Determine the following:

i. Overall accuracy, error rate and reject rate

[3 marks]

ii. Accuracy, error rate and reject rate for class α, where α is the last non-zero digit of your student ID

[3 marks]

iii. The number of false positives for class α

[2 marks]

Predicted Object Class

True Object Class	1	2	3	4	5	6	7	8	9	R
1	47	0	0	1	0	0	2	0	0	0
2	0	46	1	0	1	0	1	0	0	1
3	0	2	45	0	1	0	0	1	0	1
4	1	0	0	47	0	0	0	0	2	0
5	0	0	1	0	47	0	0	0	0	2
6	0	0	0	0	1	48	0	0	1	0
7	0	1	0	0	0	0	48	0	0	1
8	0	0	1	0	0	1	0	46	1	1
9	1	0	0	2	0	1	0	1	45	0

Figure Q3C

Continued...

Question 4

(a) Chain code is a method of describing the shape of the boundary of an object in an image. Figure Q4A shows one such object boundary.

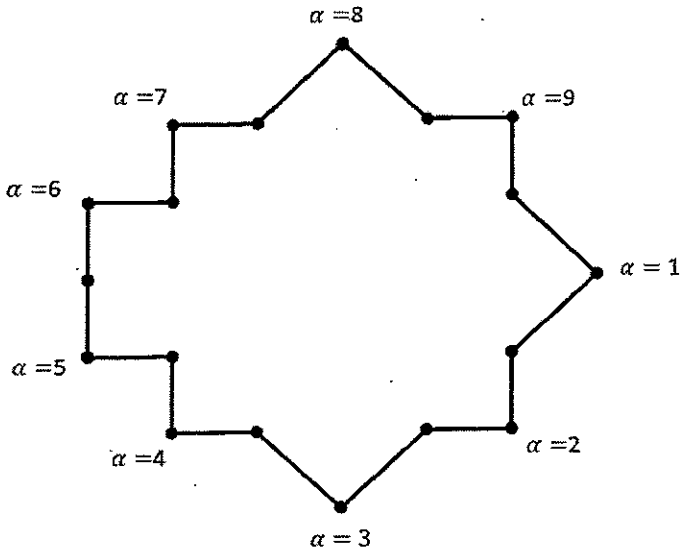


Figure Q4A

Starting from the corner point α=1, and using the 8-directional chain code shown in Figure Q4B:

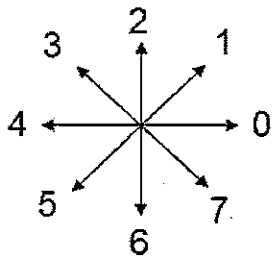


Figure Q4B

i. Derive the chain code to represent the object shape.

[3 marks]

ii. Determine the difference code and deduce the shape number to represent the boundary.

[5 marks]

iii. Explain how shape number is better than the chain code in representing the shape of object boundary.

[2 marks]

Continued...

(b) Video displays use one of two scanning methods to draw the picture on the TV screen: interlaced and progressive.

For the following two video scenes, suggest which scanning method is better at capturing each scene.

i. The scene consists of vertical bars moving horizontally
ii. The scene consists of horizontal bars (closely spaced) moving horizontally

Justify your answer.

[4 marks]

(c) The aim of motion estimation is to find the direction of motion for a block of pixels by comparing the reference and target frame. With the aid of a diagram, briefly describe the hierarchical block matching algorithm used in motion compensation.

[5 marks]

(d) Figure Q4C shows the de-interlacing process in converting interlaced into progressive video. Describe how the lines are generated if the following approaches are used:

i. Intra-frame up-conversion
ii. Inter-field up-conversion

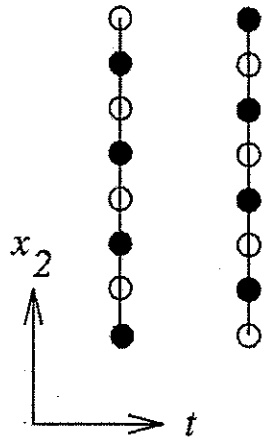


Figure Q4C

[6 marks]

End of Paper